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3 February XX, 2003
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5 EPA-SAB-EC-LTR-03-XXXX
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7 Honorable Christine Todd Whitman
8 Administrator
9 U.S. Environmental Protection Agency
10 1200 Pennsylvania Avenue, NW
11 Washington, DC 20460
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13 Subject: Review of the *Contaminated Sediments Science Plan*
14

15 Dear Governor Whitman:
16

17 An expert panel (Panel) under the Executive Committee of EPA's Science Advisory
18 Board, met on October 30-31, 2002 to review the June 13, 2002 draft document, *Contaminated*
19 *Sediments Science Plan* (CSSP). The review was conducted at the request of the Office of Solid
20 Waste and Emergency Response in Washington, D.C. at a public meeting. The Panel was
21 charged with reviewing the adequacy of the CSSP in addressing a range of contaminated
22 sediments issues, as well as considering the methods exemplified by the CSSP for cross-Agency
23 science planning. The purpose of the attached report is to advise you and the appropriate
24 management at EPA, particularly the Agency's Science Policy Council, of the Panel's findings
25 and recommendations.
26

27 The overarching goal of the CSSP is to provide a mechanism by which Agency science
28 activities that support contaminated sediments risk management decisions can be more
29 effectively prioritized, managed and coordinated. The Panel acknowledges that development of
30 the CSSP represents a major step in cataloguing contaminated sediment work at the EPA, and
31 that this alone will foster improved coordination within the Agency. However, the Agency's
32 goals for cross-Agency science planning set a performance standard for the CSSP that revealed
33 critical weaknesses in the plan's design complicating the task of review.
34

35 Consequently, the Panel sought clarification of the purpose of cross-Agency science
36 planning from EPA representatives. The Agency informed the Panel that cross-Agency science
37 planning was conceived as a necessary tool to inform and coordinate science and research
38 activities across various Agency programs. Cross-Agency science planning would function to
39 both characterize Agency science needs as well as to select and prioritize those science activities
40 required to support specific EPA environmental goals. Members of the Panel were in full
41 agreement that these functions were desirable, and if addressed systematically, could
42 significantly improve the Agency's effectiveness in managing the risks associated with complex,
43 multi-jurisdictional environmental issues.
44

45 The selection of contaminated sediments as the first multi-jurisdictional environmental
46 issue on which to apply the cross-Agency science planning process was a courageous choice, as

the area is multifaceted and broadly affects a number of Agency program offices. The Panel acknowledged the significant level of effort expended by the CSSP work group in compiling the information contained in the CSSP draft. While this effort will substantially contribute to building awareness of important contaminated sediment work across the Agency, its value as a foundation for coordinating current and future contaminated sediments science activities is compromised in the absence of knowledge regarding the research being conducted on sediments in other Federal, State and regional governments. The Panel asserts that a broader review of pertinent science is necessary for the Agency to ascertain research priorities.

The Panel identified other substantive deficiencies in the draft document that also limit its value as a basis for science planning. The Panel was particularly concerned with the absence of a coherent framework governing plan development, implementation and assessment. In the absence of this framework and identifiable criteria for science priority setting, the material presented in the draft document is most reasonably viewed as an “inventory” or “synthesis” of the Agency’s current contaminated sediment science related activities.

The need for the development of a defensible science planning framework is so fundamental to addressing complex and multi-jurisdictional environmental problems, that the Panel does not recommend extensive revision of the CSSP work group’s document, although numerous technical comments and suggestions for improvement are provided in this review. Instead, the Panel suggests that the development of a model science plan, undertaken with sufficient resources and a coherent vision, should proceed on a separate track targeting an alternative technical area, one that is less complicated, more easily assembled, and offering a fresh approach to development of a defensible cross-Agency science plan. The need to revise the CSSP, and the process to produce an unassailable contaminated sediments science plan, should be evaluated by the Agency once a satisfactory model science plan has been developed.

The Panel repeatedly returned to questions of science planning design in the discussion of the CSSP Agency charge questions. A strong consensus emerged among the Panel members that the CSSP suffered primarily from an absence of a clear process for the development of a science plan and that a systematic and transparent planning framework was necessary to establish credibility to the recommendations. In constructing the required framework, the Panel recommends that the Agency include the following elements.

- An explicit statement of the rationale and *process* used to support both the identification of cross-Agency science gaps and the associated science activity recommendations designed to fill those gaps.
- A full and explicit description of the criteria used to prioritize the science needs as well as recommendations.
- A description of the cross-Agency science plan’s implementation framework that clearly identifies the roles and responsibilities of those Agency offices accountable to senior management for successful execution of the plan.

92 The absence of selection criteria and a transparent framework in the draft CSSP had
93 limited the Panel's ability to respond to the charge questions. For example, Charge Question
94 Two asked if the major areas of contaminated sediment science identified in Chapters Two and
95 Three are addressed adequately. The Panel observed deficiencies in the area of human health
96 and risk communication, however, in the absence of explicit selection criteria, it was far from
97 evident to what extent these areas or others were suitably considered. Similarly, with Charge
98 Question Three (addressing the suitability of the CSSP recommendations), without a full
99 description of the process (and criteria) used to formulate these recommendations, an
100 unequivocal statement as to their adequacy was not possible.

101
102 To summarize, the Panel supports the intent of cross-Agency science planning as
103 described in the draft CSSP Section 1.0 Goals and Objectives. In particular, Figure 1-1 on Page
104 2, "expected results: Improved environmental decision-making which is more informed and has
105 a sound science basis" reflects the Panel's unanimous opinion of what science planning should
106 accomplish. However, the Panel finds that the CSSP as submitted lacks the framework required
107 of a science plan for defensible science activity selection, prioritization and evaluation. The
108 present document provides a valuable inventory of current and ongoing Agency research efforts
109 dealing with contaminated sediments. The Panel recommends that the current version of the
110 CSSP be renamed to more accurately reflect its content.

111
112 We hope the recommendations contained in the attached report offer a constructive
113 contribution to the development of science planning at EPA, and the safe, effective management
114 of contaminated sediments. The Panel will be pleased to answer any questions you or your staff
115 may have.

116
117 Sincerely,
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119
120 Dr. William Glaze, Chair
121 EPA Science Advisory Board
122

Dr. Michael McFarland, Chair
EPA Science Advisory Board
Contaminated Sediments Science
Plan Review Panel
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126 NOTICE

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128 This report has been written as part of the activities of the EPA Science Advisory Board,
129 a public advisory group providing extramural scientific information and advice to the
130 Administrator and other officials of the Environmental Protection Agency. The Board is
131 structured to provide balanced, expert assessment of scientific matters related to problems facing
132 the Agency. This report has not been reviewed for approval by the Agency and, hence, the
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160 Administrator, senior Agency management, appropriate program staff, interested members of the
161 public, and is posted on the SAB website (www.epa.gov/sab). Information on its availability is
162 also provided in the SAB's monthly newsletter (Happenings at the Science Advisory Board).
163 Additional copies and further information are available from the SAB Staff [US EPA Science
164 Advisory Board (1400A), 1200 Pennsylvania Avenue, NW, Washington, DC 20460-0001; 202-
165 564-4533.

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167 science plan, assessment

**U.S. Environmental Protection Agency
Science Advisory Board
Executive Committee
Contaminated Sediments Science Plan Review Panel**

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**Report of the Science Advisory Board Executive Committee
Panel on the Contaminated Sediments Science Plan**

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Report of the Science Advisory Board
Executive Committee Panel on the Contaminated Sediments Science Plan

I EXECUTIVE SUMMARY

The US Environmental Protection Agency (EPA) Science Advisory Board (SAB) established a panel to review the Agency's Contaminated Sediments Science Plan (CSSP). The Panel was convened under the SAB Executive Committee and charged with reviewing the adequacy of the CSSP in addressing a range of contaminated sediments issues, as well as considering the methods exemplified by the CSSP for cross-Agency science planning.

The overarching goal of the CSSP communicated by EPA to the Panel is to provide a mechanism by which Agency science activities that support contaminated sediments risk management decisions can be more effectively prioritized, managed and coordinated. The Panel learned from the Agency briefing that an impetus for this planning effort arose from the Agency's Corrective Action Strategy response to Government Accounting Office (GAO) recommendations in 1994. It was learned that the U.S. EPA's Science Policy Council (SPC) established the Agency-wide "science plan" as a mechanism to facilitate the coordination of Agency-wide science activities that support crosscutting, multi-jurisdictional environmental issues. In 2000, the SPC identified the management of contaminated sediments as an important cross-Agency environmental issue, the coordination of which could benefit significantly from the implementation of a science plan. The Contaminated Sediments Science Plan (CSSP) is the first Agency science plan to be developed, according to background included in the Agency's CSSP briefing to the Panel.

The CSSP identified three goals:

1. Development and dissemination of tools and science necessary to address the management of contaminated sediments;
2. Enhancement of the level of coordination and communication of science activities dealing with contaminated sediments across the Agency; and
3. Development of an effective, cost-efficient strategy to promote these scientific activities, including research.

A summary of the Panel's responses to the Agency's charge questions follow.

Charge Question 1: *Are the goals and objectives of the plan understandable and appropriate to the subject and does the CSSP adequately convey the need for such a planning document?*

The CSSP was an ambitious undertaking that documents current Agency science activities and needs associated with contaminated sediments including research, management, implementation and communication. Its breadth and description of the technical complexities and scientific

unknowns reflect a clear sense of the need for systematic and careful planning if effective risk management decisions are to be developed for contaminated sediment sites.

While the Panel commends the Agency's formulated goals, which are clear, the Panel concluded that the CSSP does not identify science gaps or propose recommendations with a process that is scientifically defensible or transparent. Because the Panel finds the overall framework for the CSSP to be weak, it was unable to conclude that the report itself substantiated the need for such a planning document.

Charge Question 2: *Are the major areas of contaminated sediments science identified in Chapters Two and Three (sediment site characterization, exposure assessment, human health effects and risk assessment, ecological effects and risk assessment, sediment remediation, baseline and post-remediation monitoring, risk communication, and information management and exchange activities) addressed adequately? Are any major areas missing?*

Although Panel members agreed among themselves that the range of science areas identified within the CSSP seemed appropriate, the descriptions provided were found to be unbalanced with some topic areas characterized by missing, insufficiently described, or misinterpreted information. In particular, the section on Human Health was deemed deficient. Although the inclusion of a section on risk communication was commendable, this section was also weak. The absence of any scientific or technical criteria necessary for the Panel to methodically assess the thoroughness of the Plan precluded the Panel from a complete determination on this charge question. The Panel agreed that in order to make that determination a more transparent and systematic framework for characterizing contaminated sediment science needs was necessary.

Charge Question 3A: *Do the CSSP recommendations meet the CSSP's goals and objectives?*

In support of the three stated CSSP goals, the Agency puts forward thirty-three recommendations. Although there is some degree of overlap, twenty-five of the recommendations are mainly in support of Goal 1, and eight of Goal 2. No direct recommendations in support of Goal 3 were provided by the Agency.

Goal 1. Development and dissemination of tools and science necessary to address the management of contaminated sediments. The Panel commends the Agency for applying the risk assessment/risk management paradigm in identifying and categorizing the relevant science activities, an approach that is consistent with Agency policy and supported by the Science Advisory Board (Toward Integrated Environmental Decision-Making - EPA-SAB-EC-00-011). The report articulates many important scientific questions; however, it is not clear if these are the most appropriate set of questions. The CSSP would benefit from the application of a systematic process designed to identify and prioritize Agency science activities based on scientifically defensible criteria.

Goal 2. Enhancement of the level of coordination and communication of science activities dealing with contaminated sediments across the Agency. If a clear plan cannot be articulated now, at

minimum, the science should be better coordinated so the plan can be effectively developed. The CSSP seems particularly deficient in this area and could benefit from a more systematic approach to planning that incorporates the needs and values of stakeholders from both within and outside the Agency.

Goal 3. Development of an effective, cost-efficient strategy to promote these scientific activities including research. As noted above, the Panel identified no specific recommendations in support of Goal 3. The report does make recommendations for workshops and meetings, surveys of Agency activities related to sediments, coordination through the contaminated sediment management committee (CSMC), identification of unfunded activities and ongoing updating of the CSSP plan. Taken together, the Panel acknowledges that these tools could be viewed as a framework for implementation of specific recommendations. However, they fall short of an implementation plan, particularly with regard to the ORD research planning process.

Charge Question 3B: *Are the key recommendations clearly defined and appropriate to address the identified CSSP science needs and are the priorities identified appropriate?*

The Panel noted that most of the recommendations described in CSSP Chapters Three and Four address important scientific or program needs within the Agency and are, therefore, appropriate for inclusion in the CSSP. However, in some cases, the specific recommendations are not consistent with the identified science needs. This inconsistency appears to be the result of the absence of a systematic and scientifically defensible planning process that can be applied to identify science needs and prioritize associated cross-Agency recommendations. Given that the CSSP has failed to demonstrate that it was developed using a systematic process or framework, the Panel finds it difficult to discern the relevance of the proposed implementation time frames for the recommendations.

Charge Question 3C: *Are the CSSP's recommendations responsive to the identified need for coordination, particularly intra-agency.*

By its very nature, the Panel sees that the CSSP is responsive to the goal of improved intra and inter-Agency coordination. The Panel questioned the absence of a more thorough description of the role of other Federal agencies, states and tribes in its research description, and science information management and exchange activities. Active and continuing collaboration with these and other outside agencies, and greater attention to how the Plan is responsive to the concerns of stakeholders is considered by the Panel to be essential to the ultimate success of any EPA contaminated sediment science planning effort. The Panel, without reservation, strongly encourages the Agency to fully acknowledge that work and evaluate whether specific Agency science needs or recommendations are currently being addressed by other agencies in any further development of the CSSP. The key recommendations provided by the CSSP provide a clear indication of Agency offices and programs that should be involved in a coordinated effort. Most of the key recommendations list other federal agencies as suggested partners, but the level of information provided is insufficient to clearly understand the types and range of interactions supported by the CSSP.

Without the establishment of a transparent and systematic framework for CSSP implementation including management accountability, the role of the CSMC may fall subject to parochial interests. A number of panel members expressed support for the development of a cross-Agency science plan implementation strategy that would offer greater detail than provided in the CSSP. The CSSP did not provide any description of how other planning efforts within the Agency, including the overall EPA strategic plan, were considered in its development. Effective cross-Agency science planning should ensure that science activity needs are appropriately considered within the science budgetary discussions. The CSMC (or its designated representative) must effectively coordinate and be held accountable for communicating and championing those critical contaminated sediment science needs within the Agency's Research Coordination Team (RCT) deliberations. The Panel recommends that the Agency clearly describe how the goals and objectives outlined in the CSSP are integrated with other Agency planning efforts.

In addition to responding to the specific Agency charge questions, individual Panel members also identified a number of scientific activity and planning concerns for consideration by the Agency as part of any future science plan effort targeting contaminated sediments. The Panel did not engage in extensive discussion on these suggestions, and consequently they do not represent a panel consensus, but rather highlight a set of professional opinions based upon panel member's relevant experience and scientific expertise. The suggestions and supporting rationale are provided within the text of the report.

Summary

In general, the Panel considered the CSSP to provide a valuable synopsis of the contaminated sediment related science activities in which the Agency is currently engaged. The CSSP provided both a clear and concise portrayal of the regulatory framework within which contaminated sediment environmental issues must be addressed. It also provides a detailed list of recommendations formulated to reduce uncertainties in scientific knowledge critical for supporting Agency risk-based decision-making.

Although development of the CSSP clearly represents a considerable effort by the Agency, the Panel unanimously agreed that, in its current form, the CSSP serves only as a first step in creating a defensible science plan. The Panel encourages the Agency to change the name of the CSSP, insofar as the Panel found that the document does not adequately meet the purpose for which a science plan is purportedly intended. Rather than a science plan, the panel suggests "inventory" or "synthesis document." Extensive revision of the process for developing the CSSP would be necessary to achieve the systematic and scientifically defensible product envisioned by the Panel for an EPA science plan. The Panel does not recommend comprehensive modification of the CSSP, rather advises the Agency to first revisit the fundamental issue of cross-Agency science planning.

Cross-Agency science planning, the Panel acknowledges, is a relatively new process whose success depends upon the application of a systematic, scientifically defensible framework to facilitate plan implementation, incorporate accountability and provide a clear methodology for maintaining continuous improvement. The Panel asserts that the cross-Agency science planning

process must be unassailable if it is to enhance the credibility of Agency environmental science planning and programs. Consequently, the Panel identified the following three components as necessary and integral to a defensible cross-Agency science plan.

- An explicit statement of the rationale and *process* used to support both the identification of cross-Agency science gaps and associated science activity recommendations designed to fill those gaps.
- A full and explicit description of the criteria used to prioritize the science needs as well as recommendations.
- A description of the cross-Agency science plan's implementation framework that clearly identifies the roles and responsibilities of those Agency offices that are accountable to senior management for successful execution of the plan.

It is the Panel's contention that science planning that proceeds in the absence of addressing these essential components is unlikely to generate a defensible cross-Agency science plan. The Panel agreed that, since the CSSP was not developed through the application of a transparent and systematic planning process, its value was limited in terms of providing a technically defensible blueprint for coordinating Agency-wide contaminated sediment science activities. The Panel suggests improvements to the Agency's science planning process, and recommends that the Agency develop and implement a transparent process to identify, prioritize and manage scientific information clearly in support of *risk management decision-making*. The Panel encourages the Agency to formulate a cross-Agency science planning framework based upon existing peer-reviewed planning models, citing recent SAB advice to the Agency strongly endorsing a more systematic approach to identifying and prioritizing the science activities that support risk based Agency decisions (EPA-SAB-EC-00-011 - Toward Integrated Environmental Decision-Making).

The complexity of contaminated sediment science requires a broad based interdisciplinary approach involving social scientists, economists, engineers, legal scholars and the full range of life and earth scientists. Given this complexity the Panel recommends that the Agency consider selecting a simpler subject as the focus for its initial science planning effort. This approach would allow timely development of the required planning framework and its implementation from research priority setting to the evaluation of plan effectiveness. Following Agency testing and acceptance, the resulting planning process could be applied to the subject of contaminated sediment science.

Report of the Science Advisory Board
Executive Committee Panel on the Contaminated Sediments Science Plan

2. BACKGROUND AND CHARGE TO THE REVIEW PANEL

The Science Advisory Board Executive Committee convened an expert panel (Panel) to review the June 13, 2002 draft document, *Contaminated Sediments Science Plan* (CSSP). The review was conducted at the request of the Office of Solid Waste and Emergency Response (OSWER) in Washington, D.C. at a public meeting, October 30 and 31, 2002. The Panel was charged with reviewing the adequacy of the CSSP in addressing a range of contaminated sediments issues, as well as considering the methods exemplified by the CSSP for cross-Agency science planning.

The CSSP states its intended functions are the development and coordination of cross-Agency science activities in the contaminated sediments area. These functions are performed by providing an analysis of the current Agency science activities in this area, identifying and evaluating the science gaps, and providing recommendations for filling these gaps. The CSSP reports that sediment contamination is an issue that cuts across offices and jurisdictions throughout the Agency, other federal agencies, state agencies, and tribes; and that significant resources are spent by a number of Agency offices to address contaminated sediment problems. U.S. EPA offices identified by the CSSP that are addressing this problem include: the Superfund Program, Office of Water, Office of Solid Waste, Great Lakes National Program Office, Office of Pollution Prevention and Toxic Substances, Office of Research and Development, and U.S. EPA Regional Offices. These offices operate under the mandate of many statutory provisions including the Comprehensive Emergency Response, Compensation, and Liability Act (CERCLA), the Resource Conservation and Recovery Act (RCRA), the Clean Water Act (CWA), the Oil Pollution Act (OPA), the Toxic Substances Control Act (TSCA), and the Marine Protection, Research, and Sanctuaries Act (MPRSA).

OSWER provided a briefing, where the Panel learned that in response to the crosscutting and multi-faceted dimensions of the Agency's contaminated sediment program, EPA's Science Policy Council (SPC) initiated in 2000 the development of the Contaminated Sediments Science Plan (CSSP). The impetus for this planning effort arose in part, the Panel learned, as an element of the Agency's Corrective Action Strategy response to Government Accounting Office (GAO) recommendations in 1994. Science planning is intended to improve multi-media integration of the research planning process. Therefore, a principal function of the Agency-wide science plan is to provide a systematic means to portray and fully integrate the Agency's science needs associated with cross-cutting environmental issues into the established research prioritizing and budgeting framework. In effect, the Panel observes, an Agency-wide science plan must transparently inform research-planning deliberations so that the final list of Agency supported research activities clearly and appropriately reflect Agency environmental priorities. The CSSP states that it does not constrain recommendations to fit prescribed resources. Instead, the recommendations are a comprehensive list that U.S. EPA organizations can consider when balancing resource allocations across competing high-priority needs.

The CSSP reports itself to be the first formal example of an Agency science plan on a specific cross-Agency office- and region-wide activity. The expectation was communicated to the Panel

by the Agency charge that additional science plans, addressing other cross-cutting issues, will be formulated to improve EPA's environmental decision-making, and conserve both human and financial resources.

Three goals are stated in the CSSP to promote a strong scientific basis for addressing contaminated sediments:

1. Development and dissemination of tools and science necessary to address the management of contaminated sediments.
2. Enhancement of the level of coordination and communication of science activities dealing with contaminated sediments across the Agency.
3. Development of an effective, cost-efficient strategy to promote these scientific activities, including research.

The SAB Panel's overall evaluation and assessment of the CSSP included the following activities:

- Providing comprehensive written responses to specific Agency's charge questions, including recommendations to improve the CSSP for Agency consideration;
- Evaluation of the general intent of the cross-Agency science planning process; and
- Development of recommendations to improve the current Agency science planning structure.

In reviewing the CSSP, the Panel's deliberation gradually differentiated into the following categories of comments, which form the structure of the Panel's report:

- Responses to the Agency's charge questions;
- Recommendations that speak more generally to the overall process of cross-Agency science planning, including scientific defensibility and management; and
- A list of science activity recommendations specifically tailored to fill important gaps in the Agency's current contaminated sediment science knowledge base.

The Panel's initial efforts were focused on addressing the specific Agency charge questions. However, in formulating its responses to the charge questions, the Panel was challenged to understand the purpose of cross-Agency science planning, including how the design of the CSSP as a model science plan could be improved to serve the Agency's mission. The need for adopting a systematic science-planning framework, transparency of criteria used for prioritization of science plan recommendations, coordination of stakeholder participation, and management accountability for science plan implementation were issues that clearly went beyond the Agency charge; but became critical in the Panel's response to the charge. The Panel

503 felt compelled to address these critical and far reaching concerns, given the role of the CSSP in
504 establishing a defensible model for future cross-Agency science plans.

505
506 Following Agency briefings to the Panel on October 30, 2002 describing the role of the CSSP in
507 coordinating Agency supported science activities, the Panel found it necessary to modify its prior
508 understanding of the organizational focus and intent of the CSSP. The following bullets, which
509 were presented to and received concurrence from Agency staff at the October 30 & 31st Panel
510 meeting, summarize the Panel's current understanding of the function of the CSSP in managing
511 contaminated sediment related science activities.

- 512
513 • Identify and compile those contaminated sediment science activities and needs from
514 across the Agency that are determined to be critical in establishing defensible risk-based
515 environmental decision-making.
- 516
517 • Use the compilation and synthesis of Agency-wide contaminated science activities and
518 needs to promote more effective coordination and communication of science activities
519 across Agency program offices and regions.
- 520
521 • Establish science priorities across the Agency by determining the extent to which science
522 needs are being addressed by current Agency science activities.
- 523
524 • Encourage the Agency-wide adoption of a science plan paradigm as a cost-effective
525 approach for establishing science priorities and associated allocation of resources when
526 addressing cross-cutting, multi-faceted, multi-jurisdictional environmental issues.
- 527

528 The Agency's clarification of the CSSP's anticipated function in coordinating science activities
529 was welcomed by the Panel and permitted a more focused set of responses to the specific
530 Agency charge questions.

531 532 **U.S. EPA CHARGE TO THE SAB CSSP REVIEW PANEL**

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534
535 The charge questions, which were formulated by an intra-Agency contaminated sediments task
536 group, were presented to the Panel as follows:

- 537
538 1) The Contaminated Sediments Science Plan (CSSP) is the first official Agency science plan
539 of its kind designed to address a significant cross-agency environmental issue in a
540 systematic and integrated fashion. Chapter One of the CSSP discusses the goals,
541 objectives, and how the CSSP relates to the Agency's mandate. Are the goals and
542 objectives of the plan understandable and appropriate to the subject, and does the CSSP
543 adequately convey the need for such a planning document?
- 544
545 2) Chapter Two of the CSSP provides an overview of the contaminated sediment problems
546 and issues across the Agency. The brief description of issues in Chapter Two is meant to
547 provide the overall context for the more detailed discussion of specific science needs given
548 in Chapter Three. Are the major areas of contaminated sediments science identified in

Chapters Two and Three (sediment site characterization, exposure assessment, human health effects and risk assessment, ecological effects and risk assessment, sediment remediation, baseline and post-remediation monitoring, risk communication, and information management and exchange activities) addressed adequately? Are any major areas missing?

3a) Chapter Four provides the key recommendations for future Agency priority science activities, including research, from the identified research needs and discussion in Chapter Three. For each recommendation, critical U.S. EPA partners and the immediate or long-term nature of the science activity are proposed. Do the CSSP recommendations meet the CSSP's goals and objectives?

3b) Are the key recommendations clearly defined and appropriate to address the identified CSSP science needs, and are the priorities identified appropriate?

3c) Are the CSSP's recommendations responsive to the identified need for coordination, particularly intra-agency?

The Panel's responses to the Agency's charge questions (sections 3-7) are targeted narrowly to address only the question as posed. Section eight offers more detailed suggestions by Panel members arising from their discussion of the charge questions; and section nine makes recommendations for the development of future science plans. None of these responses should be construed by the Agency as an endorsement to substantially revise or otherwise modify the CSSP but, rather, should be recognized as strategic and technical guidance that the Agency may wish to consider as it addresses the issue of contaminated sediments, and in the development of future science plans.

3. RESPONSE TO THE EPA CHARGE BY THE REVIEW PANEL

Charge Question 1: *Are the goals and objectives of the plan understandable and appropriate to the subject and does the CSSP adequately convey the need for such a planning document?*

The Panel learned that the CSSP represents the result of nearly two years of effort by a multidisciplinary group of Agency staff familiar with and working in the area of contaminated sediments. The CSSP was an ambitious undertaking that documents current Agency science activities and needs associated with contaminated sediments including research, management, implementation and communication. It considers both short-term science gaps and long-term risk reduction strategies. Its breadth and description of the technical complexities and scientific unknowns reflect a clear sense of the need for systematic and careful planning if effective risk management decisions are to be developed for contaminated sediment sites.

However, to conclude that the CSSP does adequately *convey* the need for such a planning document would suggest that it was demonstrated through addressing those needs. It would require that the identified science gaps and proposed Agency recommendations resulted from the implementation of a scientifically defensible and transparent planning process. The Panel

concluded that the CSSP does not accomplish this and thus leaves open the question if a planning document such as described by the CSSP is indeed needed. The Panel commends the Agency's formulated goals, which are clear, reasonable and rich in meaning. The importance of defensible science planning for the coordination of multi-jurisdictional environmental issues is clear. Without a transparent and systematically developed framework to support science planning, Agency risk management decisions are vulnerable to claims of inconsistency and/or bias. In structuring this framework, the Panel strongly recommends science coordination within the Agency as well as with external organizations (federal, state and regional) that are currently addressing contaminated sediment issues.

The Panel applauds the Agency's recognition of the need for careful planning of science activities for crosscutting, multifaceted and multi-jurisdictional environmental issues. However, the Panel was unable to assess whether the CSSP development process adequately considered fundamental questions related to defensible science planning e.g., was the CSSP development based on cross-agency communication, how are the annual science priorities established by the Agency, how do the science priorities affect the call for proposals from external organizations and/or the annual science plans by EPA region, laboratories, hazardous substance research centers, etc.? A clearer description of the process employed by the Agency in developing the CSSP would provide a basis for evaluating its need and importance within the larger Agency planning framework.

Finally, with respect to the appropriateness of its stated goals, the Panel suggests that the Agency consider explicitly highlighting the adaptive nature of the CSSP. Because the Agency reportedly intends for the CSSP to be continuously updated to reflect both current Agency science needs, as well as the latest scientific information relevant to contaminated sediment management, this characteristic of the CSSP should be emphasized.

Charge Question 2: *Are the major areas of contaminated sediments science identified in Chapters Two and Three (sediment site characterization, exposure assessment, human health effects and risk assessment, ecological effects and risk assessment, sediment remediation, baseline and post-remediation monitoring, risk communication, and information management and exchange activities) addressed adequately? Are any major areas missing?*

Although Panel members agreed among themselves that the range of science areas identified within the CSSP seemed appropriate, the descriptions provided were found to be unbalanced with some topic areas characterized by missing, insufficiently described, or misinterpreted information. In particular, the section on Human Health was deemed deficient. Although the inclusion of a section on risk communication was commendable, this section was also weak. The absence of any scientific or technical criteria necessary for the Panel to methodically assess the thoroughness of the Plan precluded the Panel from a complete determination on this charge question. The Panel agreed that in order to make that determination a more transparent and systematic framework for characterizing contaminated sediment science needs was necessary.

Beyond the Panel's concerns regarding the absence of science activity selection criteria, several panel members expressed disappointment with the limited depth of technical transfer and

capacity building activities described in the CSSP. Project managers and regional technical support staff would benefit from direct access to research laboratory scientists and the ability to develop studies designed to reduce major uncertainties in the information and models utilized for scientifically defensible decision-making. The primary means to achieve effective technology transfer identified in the CSSP consisted of conducting workshops and developing guidance documents. While these are important elements, greater benefit would be achieved by the Agency from placing greater emphasis on incorporating information of new technologies and approaches applicable to contaminated sediment management within existing regional training programs. For those technologies developed within the private sector, one panel member suggested that the Agency explore the potential of utilizing the Environmental Technology Verification (ETV) program for systematically capturing stakeholder needs and values in the development of appropriate testing protocols as well as for the diffusion of technology performance data.

Several panel members noted that the development of innovative technologies that support defensible contaminated sediment decision-making will be of marginal value to stakeholders if their costs and/or required user skill level is prohibitive. To reduce costs and promote greater utilization of new technologies, a number of panel members expressed strong support for the explicit consideration of technical training needs in all cross-Agency science plans.

Charge Question 3A: *Do the CSSP recommendations meet the CSSP's goals and objectives?*

In support of the three stated CSSP goals, the Agency puts forward thirty-three (33) recommendations, divided across eight categories, and classified according to long versus short-term priorities. Although there is some degree of overlap, twenty-five of the recommendations are mainly in support of Goal 1 (A.2 through A.4, B.1 through B.4, C.1 through C.4, D.1 through D.7, E.1 through E.5, F.1, and G.1), and eight of Goal 2 (A.1, F.2, and H.1 through H.6). No direct recommendations in support of Goal 3 were provided by the Agency. For each recommendation, the Agency program offices (and, in some cases, other federal agencies) that are principally involved in its implementation are identified. In addition, there is a Section 4.3, which is entitled Recommended Approaches to Implement Strategy. The following Panel responses address the adequacy of CSSP recommendations in satisfying each of the three specific goals.

Goal 1. Development and dissemination of tools and science necessary to address the management of contaminated sediments. The Panel commends the Agency for applying the risk assessment/risk management paradigm in identifying and categorizing the relevant science activities, an approach that is consistent with Agency policy and supported by the Science Advisory Board (Toward Integrated Environmental Decision-Making - EPA-SAB-EC-00-011).

The report articulates many important scientific questions; however, it is not clear if these are the most appropriate set of questions. The CSSP would benefit from the application of a systematic process designed to identify and prioritize Agency science activities based on scientifically defensible criteria. In its current format, it is unclear how the CSSP ensures that critical technical issues related to contaminated sediment management have not been overlooked. For

example, issues specifically addressing sediment sampling regimes, and statistically defining adverse risk in terms of analyte measurements should be discussed in the context of reducing uncertainty. And although recommendation A.4 focuses on the need to obtain more information about endocrine disruptor compounds, arguably, the larger issue relates to the development of a framework for identifying worrisome substances *before* they are released into the environment. The Panel strongly recommends that the Agency clearly identify the process that has been applied in establishing research needs, and articulate the steps involved, the degree to which external input has been included, and the methodology for employing feedback from scientific outcomes to continuously improve the function of the CSSP.

Goal 2. Enhancement of the level of coordination and communication of science activities dealing with contaminated sediments across the Agency. Coordination and communication across the Agency are critically important areas that must be addressed. If a clear plan cannot be articulated now, at minimum, the science should be better coordinated so the plan can be effectively developed. The CSSP seems particularly deficient in this area and could benefit from a more systematic approach to planning that incorporates the needs and values of stakeholders from both within and outside the Agency. The major mechanisms that are put forward in the CSSP for achieving more effective coordination of stakeholder needs and interests are primarily workshops and conferences that target Agency managers and perhaps others from related government agencies. These are important activities, but are only a first step in addressing a technically complex and multi-jurisdictional issue such as contaminated sediment management. The Panel encourages the Agency to allocate sufficient financial and personnel resources to develop a systematic planning process with a clear aim to improve science coordination across the Agency and to facilitate communication with other governmental and non-governmental agencies dealing with contaminated sediment issues. One approach supported by several panel members includes recognizing the work of Agency scientists and managers who proactively facilitate interdisciplinary science coordination and cooperation.

Goal 3. Development of an effective, cost-efficient strategy to promote these scientific activities including research. As noted above, the Panel identified no specific recommendations in support of Goal 3. The report does make recommendations for workshops and meetings, surveys of Agency activities related to sediments, coordination through the contaminated sediment management committee (CSMC), identification of unfunded activities and ongoing updating of the CSSP plan. Taken together, the Panel acknowledges that these tools could be viewed as a framework for implementation of specific recommendations. However, they fall short of an implementation plan, particularly with regard to the ORD research planning process. In another instance, the “cost-effective” need (which is assumed to be inclusive of financial and personnel allocations) articulated in Goal 3 is not addressed. Moreover, the plan admits to recommending priorities without consideration of actual resource constraints.

The most important suggestion listed in CSSP Section 4.3 is probably the last one, namely to view the CSSP plan as an evolving document that will require continual updating and revision as new scientific information becomes available, and the Agency scientific needs and/or priorities change. The Panel supports the development of a science plan that is adaptive and flexible where advancements in both Agency policy and science can be systematically evaluated and incorporated into the CSSP document, as necessary. A number of panel members suggested that

the Agency explicitly describe the process through which new scientific information will be evaluated and incorporated into future versions of the CSSP.

Charge Question 3B: *Are the key recommendations clearly defined and appropriate to address the identified CSSP science needs and are the priorities identified appropriate?*

The Panel noted that most of the recommendations described in CSSP Chapters Three and Four address important scientific or program needs within the Agency and are, therefore, appropriate for inclusion in the CSSP. However, in some cases, the specific recommendations are not consistent with the identified science needs. This inconsistency appears to be the result of the absence of a systematic and scientifically defensible planning process that can be applied to identify science needs and prioritize associated cross-Agency recommendations.

Systematic planning requires a framework that ties together the recommended implementation activities, and thus provides a blueprint for moving forward on the recommendations and future revisions of the plan. The framework should be accompanied by realistic priorities and describe how research within the different subject areas (key scientific questions) will be coordinated and integrated across the different topic areas. Without such a framework, the CSSP will serve as little more than programmatic justification for each office's own science/research interests, rather than achieve the goal of a pragmatic, systematic and defensible approach to moving the science of environmental protection forward.

Given that the CSSP has failed to demonstrate that it was developed using a systematic process or framework, the Panel finds it difficult to discern the relevance of the proposed implementation time frames for the recommendations. Moreover, several panel members expressed discomfort with the Agency's intent to implement a relatively large number of science recommendations within the immediate time frame and questions whether this schedule is realistic given the practical limitations on financial and personnel resources. Notwithstanding the CSSP work group's disclaimer concerning resource constraints, a number of panel members questioned the utility of future science activity prioritization efforts that do not acknowledge and consider resource limitations.

Charge Question 3C: *Are the CSSP's recommendations responsive to the identified need for coordination, particularly intra-agency.*

The Panel finds that the CSSP represents a considerable effort by the Agency to organize its science activities associated with contaminated sediments so that coordination of those efforts is better achieved. By its very nature, the CSSP is responsive to the goal of improved intra and inter-Agency coordination.

The Panel questioned the absence of a more thorough description of the role of other Federal agencies, states and tribes in its research description, and science information management and exchange activities. Many states (e.g., California, Florida, Washington) have invested considerable resources in contaminated sediment science and have developed a number of useful

tools for assessing problems (some of which are mentioned in the CSSP). Moreover, NOAA, USGS and the US Department of Defense (DoD) have ongoing contaminated sediment science programs that directly address many of the key recommendations. Active and continuing collaboration with these and other outside agencies is considered by the Panel to be essential to the ultimate success of any EPA contaminated sediment science planning effort. The Panel, without reservation, strongly encourages the Agency to fully acknowledge that work and evaluate whether specific Agency science needs or recommendations are currently being addressed by other agencies in any further development of the CSSP.

The Panel commends the excellent compilation of Agency research summarized in Appendix A of the CSSP. The compilation of relevant science is useful in communicating current scientific activity. With an updating of this compilation and a more detailed cataloging of Agency research, this information may be used to identify science gaps, redundancies, research of low priority and opportunities to partner with other agencies/groups. Suggested improvements to Appendix A include the addition of complete contact information, addition of uniform resource locators (i.e., URLs) containing program documents/summaries, and the inclusion of relevant projects conducted by other federal agencies and organizations. Finally, adopting a transparent and more systematic approach to planning that appropriately balances stakeholder values and concerns with available resources is critical for ensuring the credibility of future Agency science plans. A defensible science-planning framework must specifically address how the interests and concerns of stakeholder groups are considered throughout the decision-making process.

The key recommendations provided by the CSSP provide a clear indication of Agency offices and programs that should be involved in a coordinated effort. Most of the key recommendations list other federal agencies as suggested partners, but the level of information provided is insufficient to clearly understand the types and range of interactions supported by the CSSP. In some cases, the list of partners is too numerous to provide much specificity and no contact information is provided to assist in locating interested partners within each office. Furthermore, it is unclear as to whether this list is merely a suggestion of potential future partners or, alternatively, if this list has been strategically developed through systematically evaluating Agency needs with respect to the science and technical strengths of other agencies and organizations. Some standardization in the presentation of this information would be an improvement.

The Panel understands that the CSSP is meant to be a living document that is adaptive to changing Agency focus as well as flexible in embracing new scientific information. Effective coordination must be part of a systematic program whose aim is continuous improvement. As such, science activity coordination should be a continual process applied throughout the year. As proposed in the CSSP, a once a year effort to rapidly compile information from disparate Agency groups may not be optimal. It may be more effective to form smaller and more focused intra-Agency task groups to review the status of specific science areas, plan implementation of recommendations, and improve coordination within the Agency. To provide greater confidence that implementation of cross-Agency science plans will be successful, the Agency is encouraged to establish a clear process and set of metrics that are appropriate to assess the effectiveness of science plan implementation.

The recommended implementation strategy for the CSSP lists various activities (e.g., conferences, workshops, etc.) that should improve coordination of science activities within the Agency. However, these actions are not sufficiently described to permit an assessment as to how successful they are likely to be. The process and level of authorization by which the Contaminated Sediments Management Committee (CSMC) functions to implement the CSSP should be clearly described and not left to interpretation or speculation. Without the establishment of a transparent and systematic framework for CSSP implementation including management accountability, the role of the CSMC may fall subject to parochial interests. A number of panel members expressed support for the development of a cross-Agency science plan implementation strategy that would offer greater detail than provided in the CSSP.

Effective cross-Agency science planning should ensure that science activity needs are appropriately considered within the science budgetary discussions. With regard to fully integrating the contaminated sediment science priorities into the appropriate Agency budgetary deliberations, one panel member acknowledged that the CSMC (or its designated representative) must effectively coordinate and be held accountable for communicating and championing those critical contaminated sediment science needs within the Agency's Research Coordination Team (RCT) deliberations. Without an effective mechanism to establish a meaningful dialogue with RCT representatives, cross-Agency science priorities may not find resonance with the RCT when competing against other science activities. Several panel members recommended that the CSMC should be held responsible for annually documenting both the prioritized list of science activity recommendations and its supporting technical justification for each RCT addressing science issues relevant to contaminated sediment management. This activity would, in effect, be a *de facto* order to each Program Office RCT representative to provide a full description of the ranking of science activities within the context of the RCT deliberations.

The CSSP did not provide any description of how other planning efforts within the Agency, including the overall EPA strategic plan, were considered in its development. The CSSP makes a commendable effort in clarifying how contaminated sediments science activities supports Agency GPRA goals, but it fails to provide sufficient description of how it is to be integrated with other cross-Agency planning exercises and priority setting. For example, how will the goals and objectives specified in the CSSP be coordinated with the Agency's multi-year plan for mercury, endocrine disruptors or the Metals Action Plan? The Panel recommends that the Agency clearly describe how the goals and objectives outlined in the CSSP are integrated with other Agency planning efforts.

A number of panel members expressed discomfort with the CSSP recommendation that the CSMC be tasked with the responsibility of identifying science areas where inter-Agency and/or intra-Agency partnerships are needed. From a technical standpoint, summarizing those science activities that would benefit from establishing partnerships is as important as establishing a defensible process for identifying science needs, and therefore should be identified in the CSSP itself. The role of the CSMC should be to facilitate the implementation of these partnerships, not to define them.

The Panel supports continuous improvement in intra and inter-Agency science coordination as contaminated sediment science activities move forward. For example, within the contaminated

site remedial process, affected sites (e.g., CERCLA and RCRA sites) provide important field laboratories for evaluation of technical approaches for measuring and assessing the ecological effects of contaminated sediments. Promoting more meaningful integration between research activities and site assessment has several important benefits to the Agency including: 1) the participation of research scientists in site assessment provides direct technical transfer to project managers and regional technical support staff; 2) researchers gain insight into the relevant questions and issues confronting decision-makers and the public in the application of science; 3) the establishment of a database that can be used to manage innovative technology performance information; and 4) development of pilot projects that can serve as effective teaching tools.

Finally, remedial action decision-makers are often required to select risk reduction options despite significant uncertainty associated with the results of risk assessments and/or the effectiveness of the risk reduction option selected. The Agency is encouraged to consider application of quantitative uncertainty analysis to enable risk managers to more fully comprehend the level of statistical confidence associated with their remedial action decisions.

4. ADDITIONAL COMMENTS AND SUGGESTIONS FROM PANEL MEMBERS

The Panel represented a diverse group of scientists and engineers whose breadth of technical expertise and experience offered insights the Agency management may chose to consider in addressing contaminated sediments science priorities. Although the Panel does not endorse comprehensive revision of the CSSP, in discussion of the charge questions the Panel identified technical issues, scientific needs and organizing strategies useful for any future science planning effort focusing on contaminated sediments. The suggestions are for the most part organized by the technical areas identified by the Agency as necessary for the SAB's review of the CSSP, with the exception of suggestions on the Plan's organization. In large degree they address those specific science gaps that the Panel members collectively or individually recognized as important in reducing uncertainty in contaminated sediment risk management decision-making. The Panel did not engage in extensive discussion or consensus building on these points, and consequently the listing is not represented as being unanimous, comprehensive or complete. While the recommendations are primarily focused on improvements to the CSSP, some are broad in scope and have applicability to the general activity of defensible science planning.

The Panel strongly encourages the Agency to clarify that, in its current form, the CSSP serves primarily as a first step in the development of a defensible science plan. Although the CSSP did not appear to result from any systematic and transparent approach to science planning, the document does provide a compilation of cross-Agency science initiatives, which is a necessary and important first step in the establishment of a defensible science-planning framework for contaminated sediments. To distinguish the CSSP from future Agency science plans, the Panel recommends that the title of the CSSP should be modified to more accurately reflect what the document offers: The Contaminated Sediment Science Activity and Needs Inventory or *Synopsis*. The Agency should make explicit what role the CSSP will serve in its current form, clearly differentiating that role from one that would be supported by a systematically developed cross-Agency science plan.

Sediment Site Characterization

- The CSSP makes several references to the importance of capturing the effects of sediment stability in the development of effective contaminant fate and transport models (e.g., Recommendations A1 and B4). Several panel members expressed support for the Agency's claim that evaluation of sediment stability is important for developing defensible risk management decisions. However, these same panel members indicated that the broader and more fundamental question for site characterization (and ultimately risk assessment) is whether those processes that significantly impact contaminant mobility can be adequately characterized. For example, biological processes may significantly influence both sediment stability and contaminant mobility. Unfortunately, existing fate and transport models at best consider the effects of biological activity on contaminant mobility and sediment stability in a limited way. Understanding the effects of biological activity including the role and significance of aquatic vegetation on contaminant fate and transport processes is critical for estimating human health and ecological risk. Moreover, adequate characterization of these effects represents an important opportunity for effectively targeting Agency resources to reduce model uncertainty. The Agency is encouraged to evaluate the need for establishing a scientific research program with a focus on understanding biologically mediated contaminant transport mechanisms and to organize technical workshops that will serve as an effective forum for addressing other contaminant fate and transport mechanisms that significantly reduce the level of uncertainty.
- One panel member identified the need for developing Agency guidance that specifically addresses the advantages, limitations and reliability of current sediment dating methods (e.g., Pb 210, Cs137, Be7).
- The CSSP should explicitly describe the role of floodplains in exacerbating the human health and ecological risks associated with contaminated sediments in riverine ecosystems as well as their impact on terrestrial food chains. Floodplains should be considered during sediment characterization, ecological and human exposure assessment, remediation, monitoring, and risk communication. The development of Agency guidance that describes effective approaches for characterizing and assessing the human health and ecological risks associated with floodplain contamination was supported by a number of panel members.
- Several panel members commented on the technical challenges associated with the characterization of non-aqueous phase liquids (NAPL) contamination in sediments. To effectively characterize the risks associated with contaminated sediments impacted by NAPL as well as identification of suitable risk reduction options, a more comprehensive evaluation of these types of sites is warranted. At a minimum, the Agency should consider addressing the following specific questions within a CSSP: 1) how many sediment sites are affected by sub-aquatic NAPL discharges, 2) how can NAPL impacted sites be remediated, 3) what can be done to prevent future discharges of NAPL, particularly dense non-aqueous phase liquids (DNAPL), into waterways?
- Given the significant volume of scientific literature available that describes the presence of endocrine disruptors in the environment, one panel member expressed surprise that no analytical technique for quantifying alkylphenol ethoxylates (APEs) was identified within the list of CSSP

priorities. Beyond APEs, the Agency is encouraged to consider whether or not the types and amounts of pharmaceutical compounds typically found in sediments currently pose an unacceptable risk to human health and the environment.

- The Agency's acknowledgement of the need to collect toxicity data on new contaminants of concern is commendable. Of particular importance are those contaminants that would be anticipated to be present at environmentally significant concentrations at contaminated sediment sites but which are not now routinely measured and/or characterized due to limited toxicological information (e.g., alkylated polycyclic aromatic hydrocarbons – PAHs). In the absence of this information, the results of risk modeling of contaminated sediment sites will be characterized by significant uncertainty.

- The majority of the Panel expressed support for a comprehensive multimedia approach to understanding the fate and transport of contaminants associated with contaminated sediments. To support risk based decision-making, the Agency must be able to scientifically document whether the rates of contaminant transfer between physical compartments e.g., transport from sediment to pore water, transport from pore water to the water column, transport from the water column to the atmosphere (and in the reverse direction) are sufficient to cause significant risk. Most fate and transport models assume equilibrium and/or steady state contaminant behavior, thereby ignoring the dynamic movement of contaminants within sediments. Although these modeling simplifications may be necessary for facilitating quantitative risk analysis, the conclusions drawn by decision-makers using these model results may be scientifically unsupportable. Since the formulation and structure of the fate and transport models significantly impact risk results, the Agency is encouraged to establish a scientifically defensible methodology for systematically evaluating and reducing model uncertainty.

- The Agency should include a more comprehensive discussion of the recent technological advancements in the areas of contaminant analytical detection methods, real time contaminant monitoring, remote sensing, continuous monitors with telemetry, bioassays on chips or arrays, new molecular methods for bioassays etc. all of which have the potential to significantly improve the Agency's ability to characterize sediments. Explicit discussion of these innovative technologies is important since such sensors/systems have the potential to increase our abilities to assess the temporal and spatial variability in contaminant concentrations and may reduce the overall cost of sampling.

Exposure Assessment

- Effective characterization of contaminant exposure in support of risk based decision-making may require the acquisition of specific data elements that are not necessarily associated with the physical and/or chemical characteristics of sediments. For example, one panel member suggested that the collection of data that would support the characterization of the surface micro-layer may be important for describing the transfer of organic contaminants to surface feeding biota, including aquatic insects and the birds and fish that feed upon them. Establishing a systematic approach for characterizing such factors and their influence on exposure model

uncertainty would allow the Agency to identify those mechanistic components of models that merit further scientific investigation.

- PAHs are collectively identified with PCBs as persistent and bioaccumulative toxicants, although, it is well known that the mechanisms of PAH toxicity are much different than those associated with halogenated aromatics (e.g., PAHs are much more readily metabolized and their metabolites are often of primary concern). Developing the tools to measure exposure of fish to PAHs is a science activity that is complementary to the Agency's expressed need for developing better analytical methods for evaluating fish tissue.

- Because of its potential impact on water quality, the Agency is advised to consider the risk to human health from potable water supplies impacted by pollutants associated with contaminated sediment.

- The mechanisms that regulate bioavailability will have a significant impact on site characterization, exposure assessment, toxicity assessment, and selection of effective risk management options. Because its effects are far reaching, the Agency should consider development of a systematic approach for quantifying contaminant bioavailability that includes the leveraging of Agency resources to establish collaborative partnerships with other federal agencies that currently have extensive research programs in this area.

Human Health Risk Assessment

- Several panel members commented that the Agency's contaminated sediment science program could benefit from establishing a science activity agenda that explicitly addresses the toxicological effects of contaminant mixtures. For example, although those panel members familiar with PCB human toxicity assessment methodologies generally supported the Agency's plan to evaluate the toxicology of individual PCB congeners, they highlighted the fact that Key Recommendation C.1 failed to explicitly describe *how* the Agency will utilize this information to assess the risk of PCB mixtures. The full range of science issues associated with the toxicology of contaminant mixtures to humans could be more effectively addressed if this science activity were specifically targeted by the Agency and supported by a systematically developed research plan.

- Since a significant body of scientific literature exists that describes the human health effects of many of the chemicals that have been found at contaminated sediment sites, the Agency should describe how this information was used in developing CSSP priorities. The Agency is encouraged to formulate and implement a scientifically defensible approach for selecting and prioritizing those chemicals of concern that require further human health effects investigation.

- The determination of human health risks requires the assessment of the types and levels of exposure as well as the primary routes of exposure. Since a systematic framework for evaluating contaminant exposure was not described, it is unclear what role human health exposure assessment played in developing and prioritizing those human health research needs and recommendations cited in the CSSP. For example, a scientifically defensible rationale should

have been provided by the Agency for supporting the evaluation of the human health risks associated with dermal exposure to contaminated sediments. The Agency should apply appropriate risk assessment models to systematically differentiate those exposure routes that warrant further evaluation from those that have an insignificant impact on human health risk.

- Several panel members suggested that the Agency systematically determine whether the following science activities should be assigned as priorities within the CSSP:

- 1 Characterization of chemical interactions among multiple contaminants including pesticides typically found in sediments.
- 2 Development of scientifically defensible methodologies to relate bioaccumulation results from animal studies to doses anticipated in humans.
- 3 Studies designed to investigate mode- and mechanism-of-action for single chemical species and mixtures in sediments.
- 4 Development of biomarkers that indicate exposure effect and relating these to measurable human toxicity endpoints.

- In several sections of the CSSP (e.g., 3.2. Sediment Site Characterization, 3.5 Ecological Effects and Risk Assessment), the Agency develops relatively large lists of site-specific parameters whose value could potentially impact the level of risk to human health and environment from contaminated sediments. For each of these parameters, the Agency should provide an explicit technical justification of their importance, as well as a description of the process used to establish the data quality criteria. Although several panel members expressed their support of the Agency's list of parameters, at least one panel member noted that the Agency had failed to demonstrate why resources should be expended to quantify their values. A potential approach to developing a scientifically defensible list of measurable parameters is to apply a sensitivity analysis to the selected risk assessment model in order to identify those model inputs that have the largest impact on risk results. From the subset of model inputs generated by the sensitivity analysis, those whose magnitude of uncertainty is relatively large could be targeted by the Agency as parameters that warrant further scientific evaluation (this is also applicable to ecological risk assessment).

- Sensitive sub-population studies are also mentioned within the CSSP, although no recommendations on this topic appear in the final list of Agency recommendations. This omission is a significant oversight since such studies are critical in establishing the variability of risk associated with targeted populations.

- Direct toxicity from contaminated sediments should be included within the list of human health effects (CSSP Page 10, Paragraph 2).

Ecological Risk Assessment

- Several panel members recommended that the Agency develop specific guidance for assessing risk to endangered and threatened species from contaminated sediments and for evaluating the effectiveness of various risk reduction options to mitigate risk to protected species.
- Significant limitations in the Agency's proposed use of benthic community analysis to support risk based remedial decision-making were identified. Benthic community analysis can be an effective approach for characterizing the ecological impact of contaminated sediments. However, because of the impact of habitat on benthic community diversity and population size, the Agency is encouraged to develop and apply ecological risk assessment models that appropriately address species variability.
- One panel member suggested that the Agency focus greater effort on developing additional chronic test endpoints for benthic invertebrate and fish species. For example, biological responses beyond mortality, growth impacts and reproduction effects should be considered by the Agency in establishing relevant ecological benchmarks. Environmental responses such as an impaired immune system, altered physiological function, and behavioral effects should be considered as potential endpoints. Moreover, it was suggested by a number of panel members that the Agency consider developing test endpoints employing a greater diversity of marine and freshwater test species for assessing toxicity and the effects of bioaccumulation. The goal should be to survey many species and select surrogates that represent a wide range of life history strategies and sensitivities to contaminants. Risk management decisions based on a limited number of species and test endpoints leads to increased uncertainty. To reduce uncertainty in risk decisions, the Agency is encouraged to develop a transparent and scientifically defensible process for indicator species selection that accounts for their range of sensitivities to contaminants.
- The Agency is advised to evaluate the impacts of multiple-generation exposures in aquatic organisms, including adaptations, associated fitness costs, and effects on gene structure and diversity (i.e., evolutionary impacts). Traditional toxicological testing does not take such important effects into account. The elucidation of such effects requires careful integration of field and laboratory studies.
- Developing, improving, and testing sediment quality guidelines for the protection of benthic organisms, whether empirically derived or theoretical (EqP), requires data from various contaminant gradients. Assessing risk impacts chemical-by-chemical fails to account for additive, synergistic or antagonistic chemical effects and has the potential to significantly underestimate the true exposure response. Research and guidance on approaches to assess the toxicity of mixtures of contaminants in sediment that account for interactive effects based on mechanisms of toxic action is critical for effective risk-based decision-making.
- The Agency is encouraged to develop effective scientific approaches to specifically reduce uncertainty associated with the measurement of ecological indicators. These approaches should

be included in a general discussion of interpretive guidance for toxicity tests and other indicators of ecological effect.

- A number of panel members expressed support for the Agency's decision to target science resources to assess the chronic effects of bioaccumulative contaminants on high trophic level aquatic organisms, including fish as well as marine and freshwater mammals.

Sediment Remediation And Monitoring

- The Agency's current science activities aimed at understanding the effects of sediment capping and dredging on habitat alteration are important for supporting risk based decision-making. To benefit from the research supported by outside agencies and to more effectively leverage its own resources, the Agency is encouraged to comprehensively evaluate the field data available from numerous capped and dredged sediment sites. These data could yield important and useful scientific insight into the impact of various risk management alternatives on target marine organisms and species habitat.

- Panel members expressed support for greater coordination and more extensive involvement of stakeholders from both within and outside the Agency in developing scientifically defensible contaminated sediment-monitoring guidance. Development of monitoring guidance should address the values and priorities of natural resource trustees and other stakeholders.

Risk Communication And Community Involvement

- The CSSP should be commended for raising issues concerning local knowledge and development of partnerships, rather than merely focusing on one-way explanation of information. However, the basis of most of the CSSP risk communication problem statements and recommendations is unclear. Agency efforts to manage contaminated sediments should establish meaningful consultation with the EPA office of community relations to determine stakeholder needs and priorities.

- A majority of the panel acknowledged the need for incorporating social science expertise in developing effective contaminated sediment risk communication programs. The ORD request for risk communication proposals (cited in Chapter 4) solicits ideas but was deemed to be inadequate for developing a comprehensive risk communication agenda suitable to support contaminated sediment decision-making. One panel member suggested that a systematic process be established that begins by determining if the Agency has a risk communication research agenda, and, if so, the extent to which it addresses issues relevant to contaminated sediments. If no Agency risk communication research agenda exists, one should be developed that receives input from Agency practitioners as well as academic researchers and stakeholders. In addition, survey information about risk communication research being conducted by other agencies including the National Research Council (which is developing a study to explore public participation in environmental decision-making - funded in part by EPA) should be collected and evaluated for applicability.

• Several panel members recommended that the Agency develop a transparent and defensible framework that specifically outlines how the interests and concerns of stakeholder groups are considered throughout the entire science planning decision-making process. Chapter Two would benefit from explicit recognition of the value of systematically integrating the input from a broad group of stakeholders early in the contaminated sediment risk management decision-making process.

Information Management And Exchange Activities

• A number of panel members commented that issues of data and information quality were not sufficiently addressed within the CSSP. It was further noted that Agency guidance requires that all data (scientific or otherwise) collected by or on behalf of the Agency be of the correct type and amount for its intended use including the support of Agency risk based decisions (EPA Order 5360.1, EPA QA/R-5). The Panel was unable to determine whether the data currently compiled in Agency databases is of the correct type and quality to support risk management decision-making. Furthermore, the Office of Management and Budget (OMB) has recently promulgated guidelines on information quality in response to the Data Quality Act (as amended to PL 106-554). These guidelines encourage, among other things, that information generated by the federal government that has a clear and substantial impact on public policy (including the analysis of risks to human health, safety and the environment) be characterized by objectivity, transparency and reproducibility. To ensure that the quality of information associated with the CSSP meets the intent of OMB guidance, the Agency is encouraged to recognize and fully implement the EPA quality system requirements within all science planning documents.

• Information management serves an important role in advancing the science associated with contaminated sediment management. Individual panel members commended the Agency for its decision to develop regional databases to compile, manage and store environmental data to support local risk management decisions. Furthermore, several panel members applauded the Agency's plan to expand the availability of relevant technical information to interested stakeholders by interfacing regional sediment databases with national databases (such as the National Sediment Inventory). However, to develop an effective blueprint for any database, the Agency was advised to first identify the intended audience(s) and the proposed uses of the data. The science questions that such databases are designed to support should provide appropriate guidance for its development. Utilizing a systematic approach that explicitly considers database requirements (e.g., type of data stored, interfaces needed, data quality requirements, roles of potential users, etc.) would enable the Agency to develop an efficient database structural design. Finally, the Agency is encouraged to conduct a comprehensive review of existing environmental databases to identify those that could provide relevant scientific information in support of the Agency's contaminated sediment data management system.

• One panel member reminded the Agency of the April 29, 1998 memorandum from Deputy Administrator, Mr. Fred Hansen, which addressed the need for establishing the appropriate level of data quality and included the requirement that any data quality management plan explicitly address the issue of secondary uses of data. The Agency program offices should establish meaningful coordination with the appropriate divisions within the new Office of Environmental

Information to ensure that the Agency quality system requirements are appropriately incorporated early in the development process of any future science plan.

CSSP Report Organization

- A majority of the panel supported the inclusion of statutory and regulatory framework description provided by the CSSP. This framework establishes credible compliance criteria against which to evaluate the CSSP's identified science needs. Moreover, given the stated intent of CSSP Chapter Two, which is to provide the overall context and technical justification of the science needs discussed in CSSP Chapter Three, the Agency is encouraged to consider modifying the title of this chapter to reflect the Agency's concern, e.g., overview of major sediment regulatory issues across the Agency. A number of panel members observed that the description of regulatory requirements should not only support the CSSP science activity recommendations but should be used in conjunction with other Agency guidance to generate a environmental compliance context for its recommendations.

- The CSSP provides an expanded description of each recommendation included in CSSP Section 4, which sometimes indicates the lead Agency program office and describes future activities. Unfortunately, many of the recommendations do not include this information. The Agency is encouraged to adopt a consistent format in describing the recommendations including steps needed for their effective implementation

- The Agency is encouraged to provide a set of clear and practical approaches for obtaining access to the multiple references cited in CSSP Chapter Two and all future cross-Agency science plans. Addressing this recommendation is important because documentation serves to substantiate assertions with identifiable and technically credible sources. Identification of the responsible offices within the Agency primarily responsible for addressing the contaminated sediment related regulatory compliance requirements would also enhance the value of this section.

- Although the risk assessment/risk management paradigm was deemed an appropriate framework for identifying important science gaps, a number of panel members recommended that the Agency extend the use of this approach in establishing science priorities. The application of the risk assessment/risk management paradigm in setting science priorities could be facilitated by considering the results of comparative risk, cumulative risk and/or comprehensive risk (i.e., human health, ecological, economics, social, etc.) assessments during the science planning process.

5. RECOMMENDATIONS FOR SCIENCE PLANNING AT EPA

During the two-day meeting in October, 2002 the Panel shifted deliberations from addressing the strengths and weaknesses of the plan itself to the intent of science planning at the Agency. The majority of the panel members endorsed the stated purposes for which effective science planning is needed to address crosscutting and multi-jurisdictional environmental issues. However, a

number of panel members identified many practical opportunities to significantly improve the Agency's current approach for developing a defensible and functional science plan. Many issues have already been discussed in the preceding sections. However, given the deficiencies associated with the approach used to develop the CSSP, the Panel has summarized its comments into the following eight recommendations to improve the overall process for science planning at the Agency:

- The Agency should embrace a systematic and transparent process for developing future technically defensible science plans. In particular, the Panel recommended the integrated environmental decision-making (IED) framework contained in the SAB publication: EPA-SAB-EC-00-011 Toward Integrated Environmental Decision-Making be evaluated as a reasonable first step in formulating a defensible science planning process. The IED framework recognizes that risks often are experienced simultaneously and are cumulative; that efforts to manage one risk may have impacts on other risks; and that benefit cost scenarios may be affected by the scope of the problem definition. Key elements of the IED framework are transferable to the science planning process.
- Data quality objectives (DQOs) should be established to ensure clarity on all related matters of quality assurance and quality control (QA/QC). For example, the utility of the science inventory to Agency decision-makers will be expanded by systematically incorporating technical information of *known* quality into the database.
- The Agency must ensure that financial and personnel resources sufficient to address the task of science plan development are available. The process employed for development of the CSSP was thought to reflect inadequate resources for it to be successful in the allowed timeframe.
- A systematic consideration and integration of other agency as well as external organizations' science activities will increase the efficiency of planning and leveraging of limited resources. Prioritization of cross-Agency science activity needs must consider all relevant research being conducted both within and outside the Agency.
- A cross-Agency science plan whose recommended science priorities were formulated in the absence of any consideration of the resource requirements necessary for implementation is of limited practical value. At a minimum, the cross-Agency science plan should articulate the process by which the recommended science priorities are integrated into the Agency's science budgetary structure.
- To ensure that those scientific concerns relevant to cross-Agency environmental issues are fully considered by Agency decision-makers, effective science planning requires establishing and enforcing a system of management accountability.
- The frequency at which the cross-Agency science plan should be evaluated needs to reflect different levels of review and consider "new science" timeframes as necessary. A number of panel members recommended that the Agency consider the length of the review cycle of other EPA planning activities (e.g. the ORD multi-year plan review timetable) in establishing an appropriate review frequency for the cross-Agency science plan.

- A method for systematically evaluating the use of science tools by target users should be established to provide technology developers with critical information required for future tool development. Implementing an effective methodology for gauging user satisfaction with specific science tools promotes greater management accountability while encouraging responsiveness to the needs of the user communities.

In summary, the Panel recommends the following three components as necessary and integral to a defensible cross-agency science plan:

- An explicit statement of the rationale and *process* used to support both the identification of cross-Agency science gaps and associated science activity recommendations designed to fill those gaps.
- A full and explicit description of the criteria used to prioritize the science needs as well as recommendations.
- A description of the cross-Agency science plan's implementation framework that clearly identifies the roles and responsibilities of those Agency offices accountable to senior management for successful execution of the plan.

6. REFERENCES

1. EPA-SAB-EC-00-011 Toward Integrated Environmental Decision-Making
2. EPA QA/R-5 EPA Requirements for Quality Assurance Project Plans for Environmental Data Operations
3. EPA Order 5360.1 A2 Policy and Program Requirements for the Mandatory Agency-wide Quality System
4. EPA Contaminated Sediments Science Plan Work Group, Contaminated Sediments Science Plan, June 13, 2002 Draft
5. Environmental Protection Agency FY 2001 Annual Assurance Report, Material and Agency Weaknesses, Office of Research and Development
6. Data Quality Act as appended to the 2001 Consolidated Appropriations Act PL 106-554
7. Memorandum from Mr. Fred Hansen, EPA Deputy Administrator, to Assistant Administrators on the subject of Assuring High Quality Environmental Data, April 29, 1998